Interactive chemistry/aerosols in CAM

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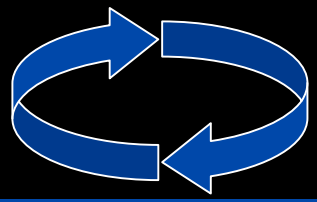
Scope of Topic

- Focus on Climate Change and Tropospheric Chemistry
  - Paleochemistry
  - Climate of the 20th Century
  - Climates of the Future
- Key Issues to Consider
  - Ozone (Health, Air Quality, Forcing)
  - Methane & Greenhouse Forcing
  - Aerosols & Hydrologic Cycle
  - Coupling to Biogeochemistry

Procedure

- Implement a flexible capability for interactive chemistry (gas phase and aerosols) in CAM; based on MOZART
- Build the coupling capabilities between CAM and the ocean/land models

- Radiative forcing by ozone, methane and aerosols
- CCN dependence on aerosol formation
- Modification of cloud albedo



CLM with carbon-nitrogen coupling ↔ CAM with interactive chemistry and aerosols ↔ Ocean with biogeochemistry

1. Deposition velocities
2. Chemical surface fluxes
3. Ozone impact on plant growth
4. Nitrogen (ammonia, nitric acid) deposition and soil fertilization

1. Deposition velocities
2. Chemical surface fluxes
3. Nutrients (dust, nitrogen) deposition and fertilization

Collaborative effort

- Strong leverage from WACCM and MOZART groups
- Collaboration with X. Tie, N. Mahowald, P. Ginoux (GFDL) and P. Rasch on aerosols
- Collaboration with P. Rasch and P. Hess on using the chemistry in the offline CAM
- Collaboration with P. Cameron-Smith (LLNL) on creating a fast mechanism
- Collaborating with LANL/LLNL/ORNL on coupling with DMS fluxes

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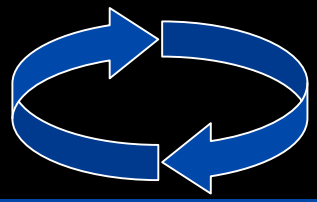

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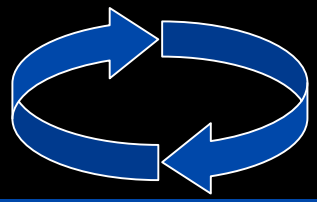

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Simulated aerosol species

- SO_2, SO_4, DMS, H_2SO_4
- NH_3, NH_4, NH_4NO_3 (based on Metzger et al.)
- OC (hydrophobic, hydrophilic)
- BC (hydrophobic, hydrophilic)
- Sea-salt (4 bins)
- SOA (based on Cheung and Seinfeld)

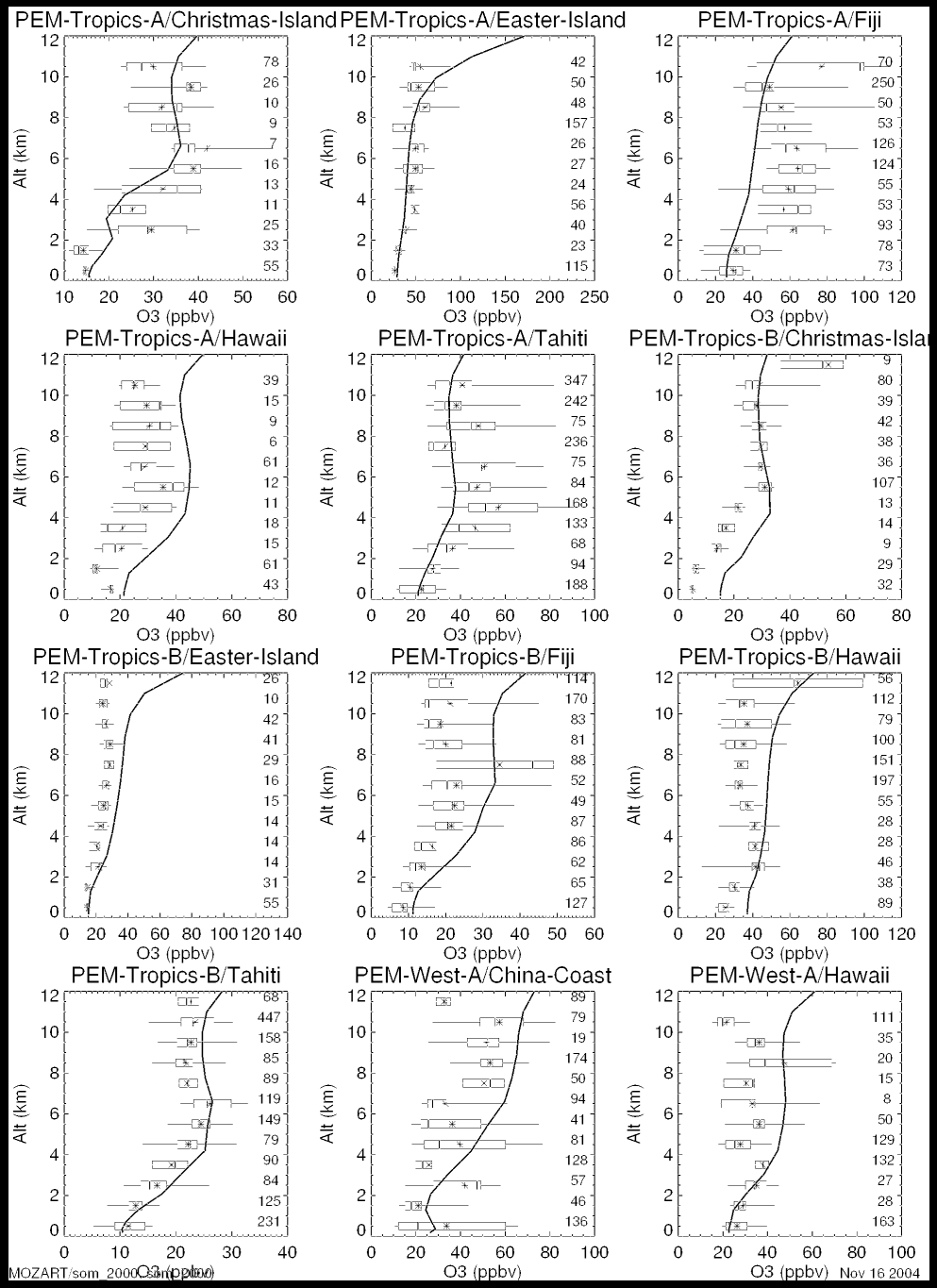
Computational cost

- Simulations have been performed in CAM3 at 2x2.5, 26 levels, fv dynamical core only
- Full tropospheric chemistry + simple aerosols (96 species)
- On bluesky, approximately 100 s/day on 64 CPUs
- That's an increase by a factor 4-5 over a no-chemistry CAM

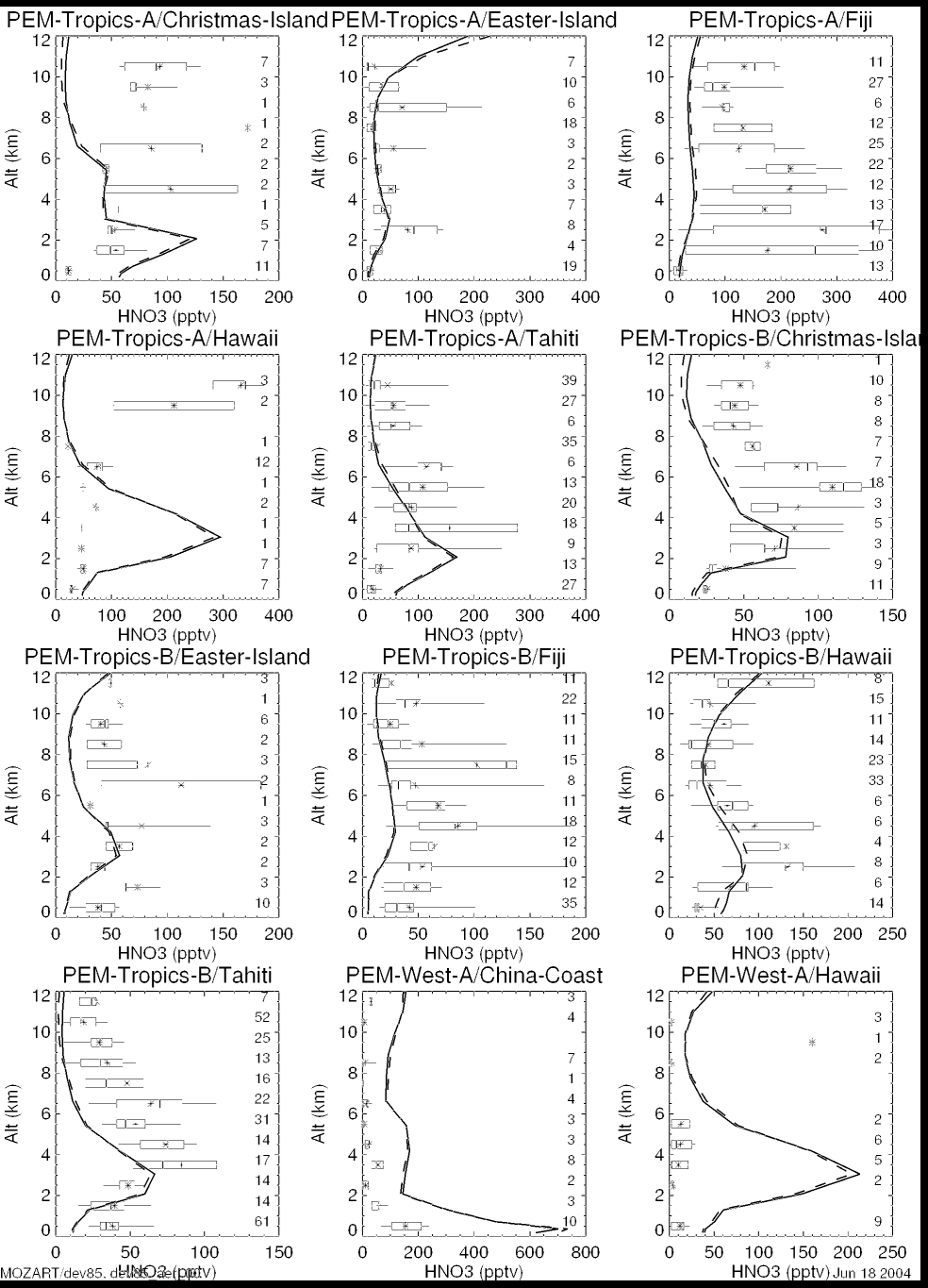
Next model developments

- Inclusion of interactive photolysis rates
- Interactive dry deposition in CLM
- Inclusion of indirect effect (collaboration with S. Ghan (PNNL) and P. Rasch)
- Model speedup

Ozone


PEM-Tropics-A/Christmas-Island
PEM-Tropics-A/Easter-Island
PEM-Tropics-A/Fiji
PEM-Tropics-A/Hawaii
PEM-Tropics-A/Tahiti
PEM-Tropics-B/Christmas-Islat
PEM-Tropics-B/Easter-Island
PEM-Tropics-B/Fiji
PEM-Tropics-B/Hawaii
PEM-Tropics-B/Tahiti
PEM-West-A/China-Coast
PEM-West-A/Hawaii
Alt (km)
O3 (ppbv)
MOZART/som_2000
Nov 16 2004

HNO_3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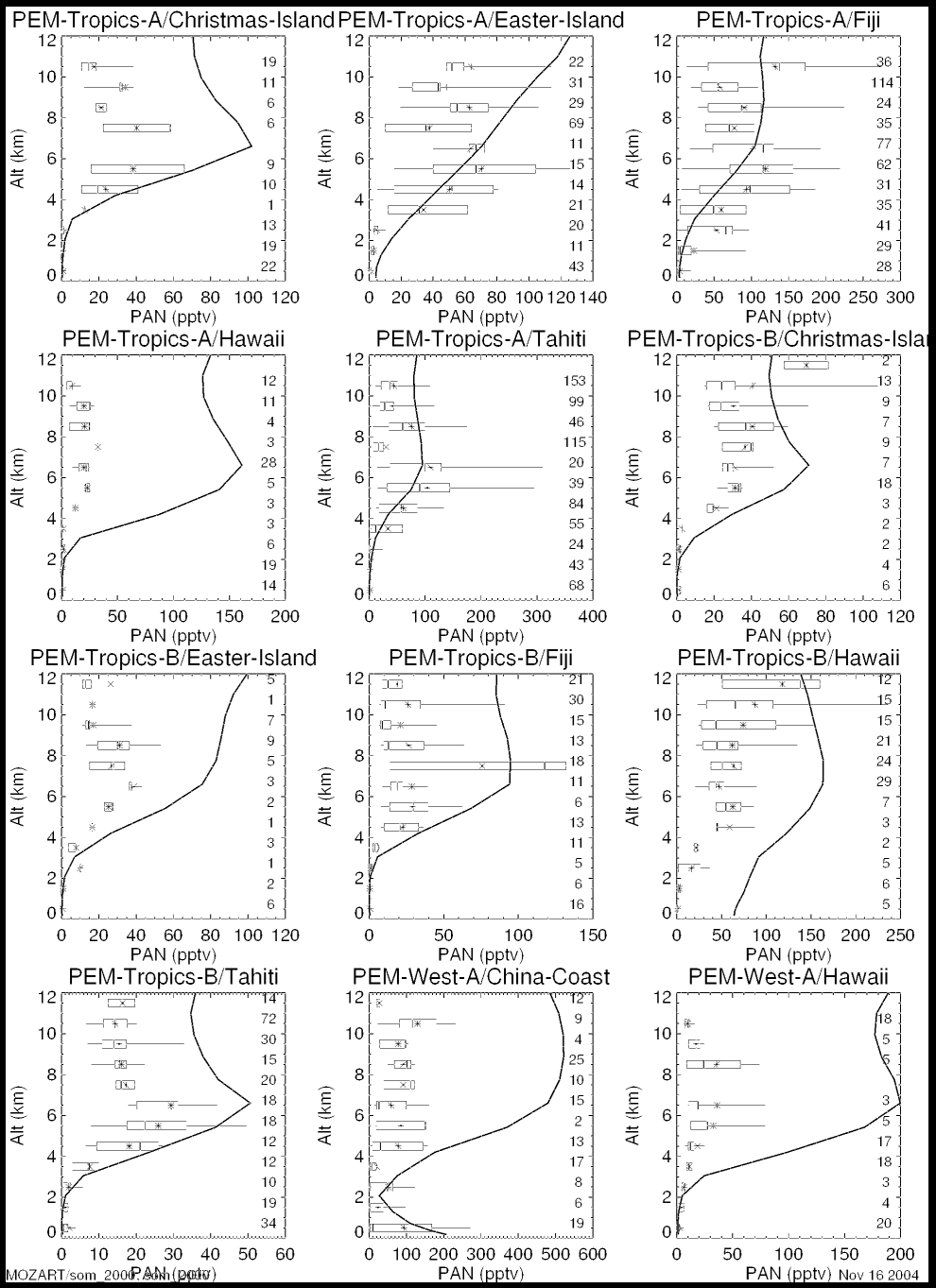
PEM-Tropics-B/Hawaii
PEM-Tropics-B/Tahiti
PEM-West-A/China-Coast
PEM-West-A/Hawaii
Alt (km)
HNO3 (pptv)
MOZART/dev85, dev85-e(pptv)
Jun 18 2004

PAN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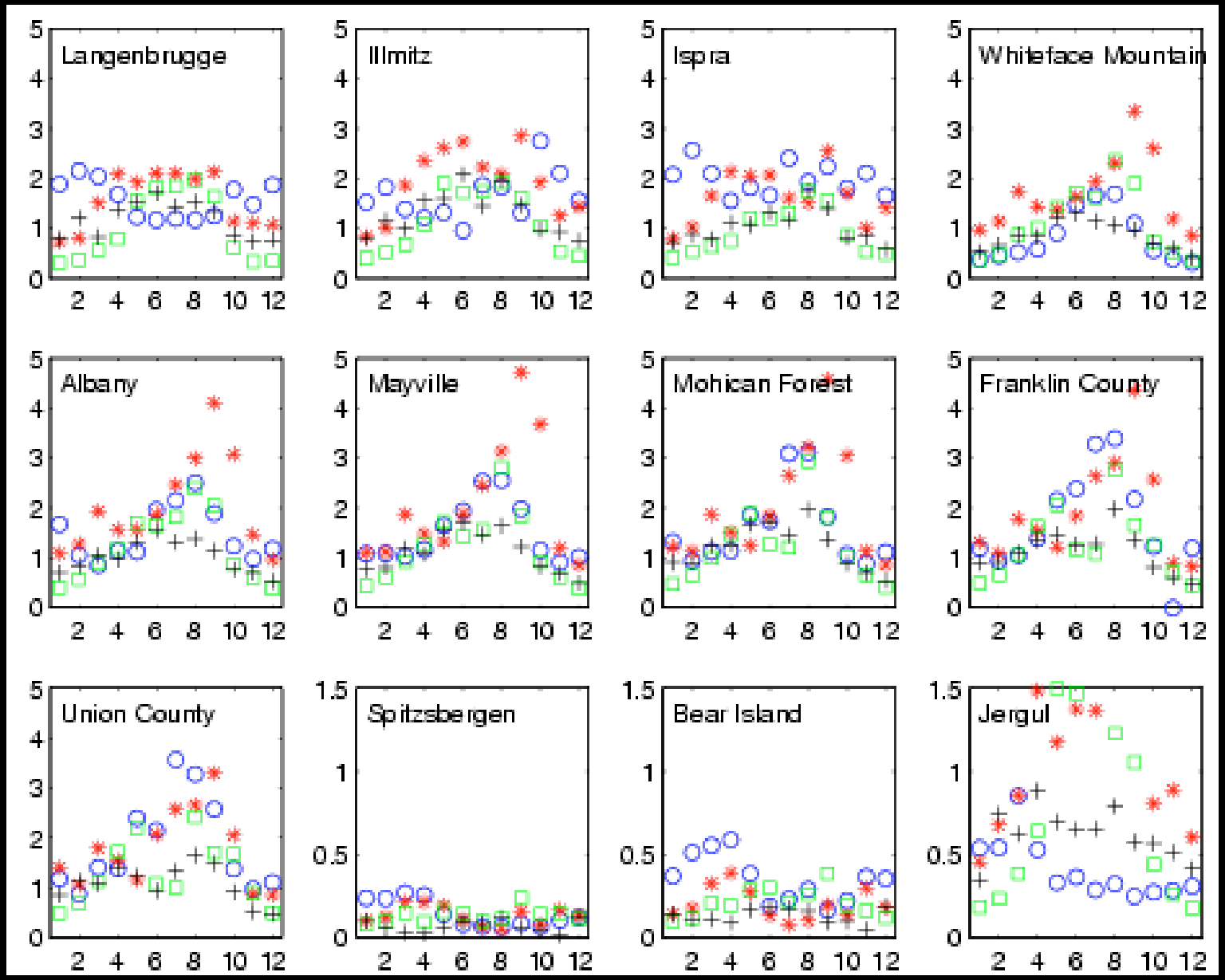
PEM-West-A/China-Coast
PEM-West-A/Hawaii
Alt (km)
PAN (pptv)
MOZART/som_2000.som (pptv)
Nov 16 2004

SO4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Illmitz
Ispra
Whiteface Mountain
Albany
Mayville
Mohican Forest
Franklin County
Union County
Spitzsbergen
Bear Island
Jergul

2000

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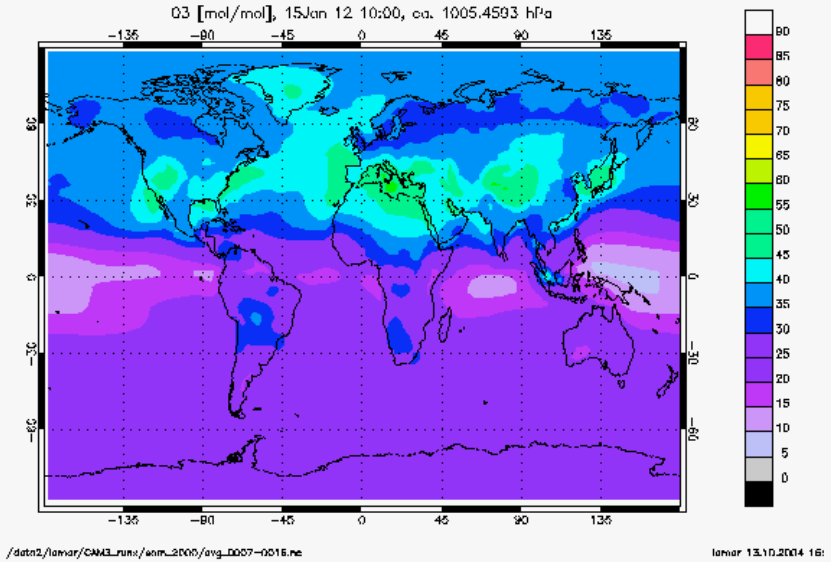
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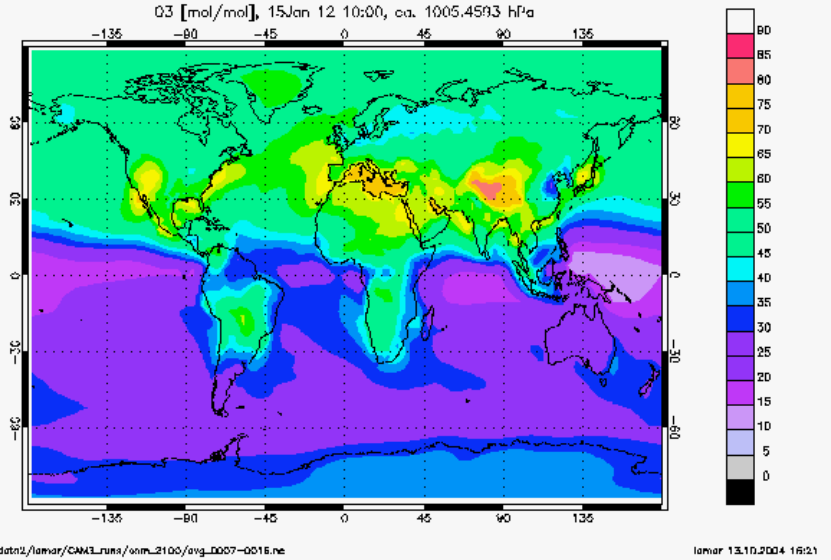
lamar 13.10.2004 15: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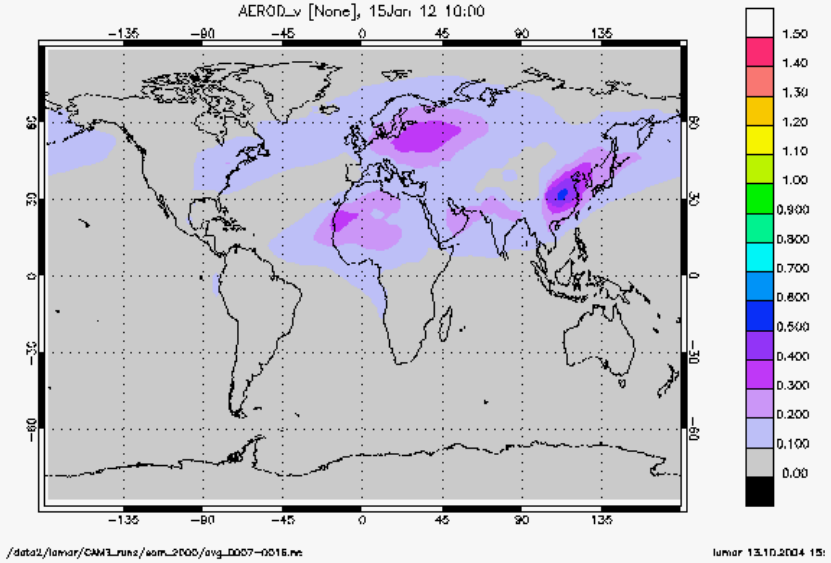
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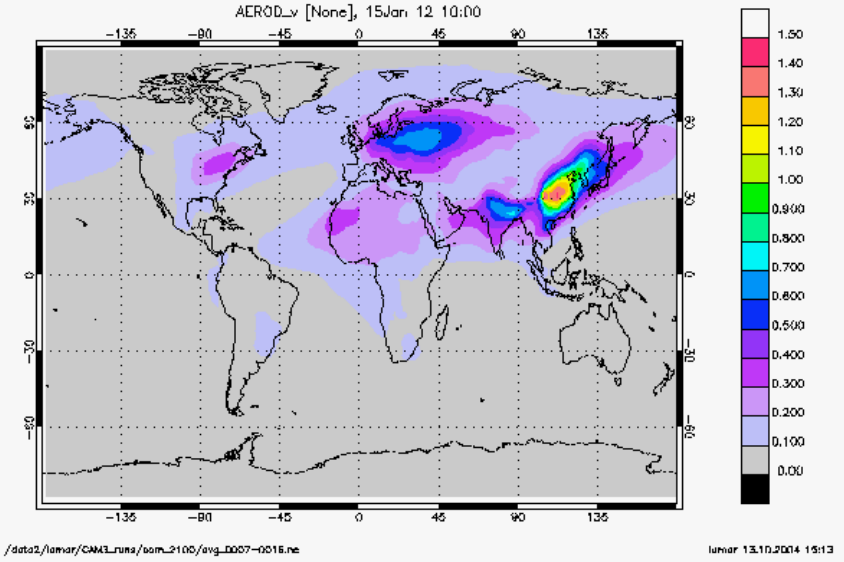
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Next steps

- Thorough model evaluation (including aerosols)
- Science study to demonstrate the importance of the coupling capability
- Work on creating a releasable version